



Admissions and Readmissions Related to Adverse Events, 2007-2014

NMCPHC-EDC-TR-579-2015

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EpiData Center Department
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Abstract

Adverse medical events place a burden on patients and cause readmissions, which account for about half of all healthcare expenses. This study assessed adverse events as they relate to readmissions in the Military Health System (MHS). Among 142,579 admissions with an adverse event in the MHS between January 1, 2007 and December 31, 2014, those with adverse events related to procedures (n=58,934) and drugs (n=53,950) were the most prevalent. There was little year to year variation in the rate of adverse event-related admissions by type with the exception of procedure-related adverse events, which decreased noticeably over the nine years of study. While the percentage of readmission was higher after radiation-related adverse events, the majority of the burden of readmission stems from the two most common adverse event types: drugs and procedures. In order to reduce the total number of readmissions, special attention should be directed toward patients who are prone to experiencing drug- or procedure-related adverse events.



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Background

Between 44,000 and 98,000 Americans die annually as a result of medical errors that could have been prevented, such as adverse drug events and surgical errors, placing health care injury among the top 10 causes of death in the United States (US). Medical errors lead to long hospital stays, readmissions, and disability, causing discomfort and burdens for patients and their families, as well as a loss in patient-provider trust. Lost days of work, income, and productivity are societal burdens of these errors, as well (Kohn, Corrigan et al. 2000) (Leape, 1994).

Hospital readmissions account for about half of all healthcare expenses, with 13% of inpatients in the US undergoing repeated admissions. Approximately one in 12 adult inpatients are readmitted within 30 days and nearly one third within one year of initial admission. Hospital readmissions, as well as increased length and cost of hospitalization, are associated with patient demographics (primarily age), complexity of illness, and environmental factors like housing, transportation, and social support (Sommers and Cunningham 2011) (Classen, Pestotnik et al. 1997) (Meurer, Yang et al. 2006).

The following study retrospectively assessed admissions and readmissions for adverse events in the Military Health System (MHS) by quantifying the number and type of adverse events between 2007 and 2014 among Department of Defense (DoD) beneficiaries hospitalized at military treatment facilities (MTFs).

Methods

Discharge information was derived from Composite Health Care System (CHCS) Standard Inpatient Data Record (SIDRs) in the MHS for all DoD AD personnel and other beneficiaries hospitalized at MTFs from January 1, 2007 through December 31, 2014. Adverse events were identified using selected International Classification of Disease, Ninth Edition, Clinical Modification (ICD-9-CM) diagnosis codes validated by Layde et al. to distinguish adverse events during the Wisconsin Medical Injury Prevention Program (Layde et al. 2005). Layde et al. defined adverse events as “any untoward harm associated with a therapeutic or diagnostic health care intervention” (2005). Adverse events in this study were defined the same way and categorized into five groups: procedures, devices (including implants and grafts), drugs, radiation, and other. The frequency and rate of hospitalizations with at least one adverse event of each category was calculated, excluding duplicate adverse event types within the same hospitalization, along with the total number of adverse events during the course of all admissions.

If an individual had multiple admissions during the study period for a given adverse event type, the earliest admission was used to determine patient characteristics. To assess the nature of adverse events, Medicare Severity Diagnosis-Related Group (MS-DRG) codes were used to determine whether a discharge was a surgical, medical, or other encounter type. MS-DRG is a classification system primarily used for billing purposes. It uses the principle and secondary diagnoses to assign clinical conditions to each patient discharge. The MS-DRG codes were used

to characterize admissions and further matched to Major Diagnostic Categories (MDCs), which describe the organ system or etiology leading to each hospital admission.

Unique patient identifiers were used to identify all admissions for each person. An index admission was defined as an admission in which an adverse event was coded at discharge. Readmission was defined as an admission within 30 days of an index admission discharge date. The 30-day timeframe was chosen to assess care given during the index admission and establish a clinical relationship among subsequent readmissions within the timeframe. If an adverse event was coded for a qualified readmission, the readmission would be treated as a new index admission. If a readmission occurred during the 30-day timeframe, the index admission was counted as being readmitted. The sum of readmissions for each index admission was also calculated and presented as the burden of readmissions along with the type of adverse event during the index admission. Furthermore, unique patient identifiers and MDC codes were matched to identify a diagnostic relationship between the index admissions and readmissions. This match served to establish an etiologic relationship between hospital stays.

Results

This study analyzed 142,579 admissions with an adverse event in the MHS among 112,131 individuals between January 1, 2007 and December 31, 2014. **Table 1** provides a summary of patient demographics by the type of adverse event experienced. In general, the number of patients with adverse events was evenly distributed among the age groups older than 18 years, with more men than women (52.6% males, 47.4% females) impacted. The majority of patients were sponsors (26.3% active duty/recruit, 29.6% other) followed by dependents (41.9%). The percentage of dependents was relatively consistent across all adverse event types, yet the proportion of active duty and recruit sponsors was substantially lower in the radiation group while other sponsors were higher.

Figure 1 presents the distribution and trend of adverse event types from 2007 through 2014. Admissions with an adverse event related to procedures (n=58,934), drugs (n=53,950), and other types of events (n=44,613) represented the majority of admissions with adverse events. The overall rate of adverse event-related admissions increased toward its highest point in 2011 (68.7 per 1,000 admissions) then decreased toward its lowest point in 2014 (66.6 per 1,000). There was little year to year variation in the rate of adverse event-related admissions by type with the exception of procedure-related adverse events, which decreased noticeably over the nine years of study, beginning with 30.6 per 1,000 admissions in 2007 and ending with 25.3 in 2014. Drug-, device-, and radiation-related adverse event admissions did not change substantially over the course of the study period. More details about the frequencies and rates of adverse events can be found in the **Appendix**.

The majority of admissions with an adverse event had a medical MS-DRG type (52.1%), while 38.8% of admissions had a surgical MS-DRG type. The remaining 9.1% of admissions with an adverse event had an MS-DRG code that did not align to a specific MS-DRG type. The most frequent MDCs among admissions with an adverse event of any type were injuries, poison, and toxic effects of drugs (13.6%); digestive system (13.4%); circulatory system (11.9%); and



musculoskeletal system and connective tissue (11.5%). Admissions with drug events were most often related to injuries, poison, and toxic effects of drugs (20.1%), while device adverse events were distributed among admissions for diseases and disorders related to the musculoskeletal system (24.4%) and circulatory system (23.7%). Procedure and radiation adverse events most often occurred during admissions for diseases and disorders related to the digestive system (**Table 2**).

Table 3 outlines the number and percentage of index admissions that were readmitted, as well as index admissions that share the same MDC code with a readmission. Procedure-related adverse events were the most frequent in the study and had the second lowest percentage of readmission (14.5%) when not accounting for the MDC code, and the second lowest percentage of readmission sharing the same MDC with the index hospitalization (5.1%). Radiation-related adverse events, on the other hand, were least frequent yet had the highest percentage of readmission for both categories (27.5% and 12.1%, respectively).

A substantial portion of all readmissions (i.e. the burden of readmissions as opposed to the incidence of readmission as described above) is shared between the two most frequently cited adverse event types: drugs and procedures. Among the 142,579 admissions with any adverse event type, there were a total of 25,856 readmissions, and 9,085 readmissions having the same MDC as the index admission (**Table 4**).

Discussion

The overall rate of admissions with an adverse event peaked in 2010 and 2011, after which a decreasing trend was observed. While procedure-related adverse event admissions were most frequent, the rate of these admissions generally decreased over the course of the study period. Drug-related adverse events were the second most frequent, yet did not change noticeably over time. The overall decreasing trend in the rate of all adverse events and procedure-related adverse events from 2011-2014 may be partially attributed to efforts undertaken by the MHS during this time period to improve patient safety and decrease hospital admissions (“Partnership for Patients”, MHS).

The findings presented here are consistent with other studies that discerned the type of adverse events experienced by patients. The comparatively high frequencies of procedure- and drug-related adverse events were expected due to the nature of each; drug usage is prone to inducing allergic or toxic reactions, while procedures, sometimes operative, involve maneuvers that may make patients more susceptible to infections and complications. The most common MDCs among adverse event-related admissions include injuries, poison, and toxic effects of drugs; digestive system; and circulatory system. MHS health care efforts should therefore be focused on these areas to curb adverse events.

Patients who had a radiation-related adverse event were most commonly readmitted. This may be due to the nature of care for radiation therapy patients, who may be more likely to seek follow-up care than those who are not undergoing radiation therapy. This finding is consistent with readmissions with the same MDC as the index admission. Matching admissions using MDCs



ensured that patients were not counted as readmitted for a different condition. While the percentage of readmission was higher after radiation adverse events, the majority of the burden of readmission among all admissions stems from the two most common adverse event types: drugs and procedures. In order to reduce the total number of readmissions, special attention should be directed toward patients who are prone to experiencing drug- or procedure-related adverse events.

Limitations

This study detected adverse events by using discharge diagnosis codes rather than a chart review, leaving the possibility of adverse events going undetected if not accounted for in the discharge record. Furthermore, chart review would have helped to discern complexity of illness, which has been identified as a key factor in patient safety. The type of hospital where they were admitted, by service, residency programs, or specializations, was not investigated in this study but could potentially reveal strengths and weaknesses of patient safety in MHS facilities. Admissions should also be further investigated for the usage of therapy-specific drugs and procedures to determine those more strongly associated with adverse events.

Readmission may not have been the only result of adverse events in this study. The patient could have experienced an increased length of stay or sustained a disability. Future studies should investigate these outcomes, as well as whether patients with adverse events were subsequently seen in the outpatient setting, and any associated increased financial burdens.

Encounter data maintained at the EpiData Center (EDC) are routinely generated within the CHCS at fixed- MTFs. Encounter data consist of ambulatory clinical encounters and inpatient discharges. These data do not include records from shipboard facilities, battalion aid stations, or in-theater facilities. Purchased care records are only available for a small number of active duty personnel with inpatient admissions. Due to data source changes, ambulatory data before 1 January 2012 have four diagnosis fields, and data after this date have ten. The number of cases for a particular condition will likely appear to increase after 1 January 2012 even if the actual number of individuals with the condition did not. This change will affect case counts over years and may make comparisons more difficult to interpret. Inpatient records are created at discharge or transfer and have 20 diagnosis fields.

Diagnoses in medical encounters depend on correct ICD-9-CM coding practices. Data for medical surveillance are considered provisional and medical case counts may change if the record is updated after the report is generated. Additionally, because records are submitted into the system at different times, there may be patients who had an inpatient encounter but were not captured in the current data.



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Tables and Figures

Table 1. Demographic characteristics of beneficiaries who experienced an adverse event, 2007 – 2014, by adverse event type

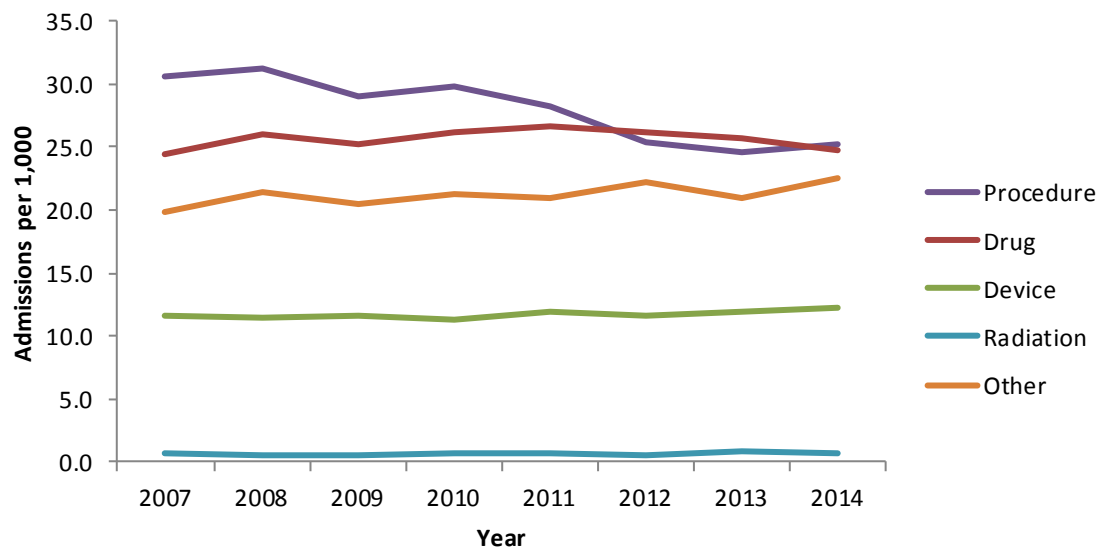
Characteristic	Drug		Device		Procedure		Radiation		Other		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Age												
0-17	3,324	7.1	933	4.7	2,393	4.8	6	0.5	2,452	6.3	7,000	6.2
18-29	13,711	29.2	3,082	15.6	12,154	24.3	29	2.6	8,236	21.1	29,055	25.9
30-44	7,589	16.2	3,274	16.5	11,527	23.1	88	8.0	9,076	23.2	22,650	20.2
45-64	10,330	22.0	6,179	31.2	13,852	27.7	375	33.9	11,427	29.3	28,636	25.5
65+	12,034	25.6	6,349	32.0	10,054	20.1	608	55.0	7,859	20.1	24,790	22.1
Sex												
Male	24,233	51.6	12,383	62.5	25,755	51.5	680	61.5	21,667	55.5	58,975	52.6
Female	22,755	48.4	7,434	37.5	24,225	48.5	426	38.5	17,383	44.5	53,156	47.4
Patient category												
Sponsor (AD/ Recruit)	12,869	27.4	3,862	19.5	12,647	25.3	59	5.3	10,300	26.4	29,540	26.3
Sponsor (Other)	13,288	28.3	8,462	42.7	15,074	30.2	666	60.2	11,954	30.6	33,199	29.6
Dependent	20,045	42.7	6,909	34.9	21,219	42.5	354	32.0	15,756	40.4	46,957	41.9
Other	786	1.7	584	3.0	1,040	2.1	27	2.4	1,040	2.7	2,435	2.2
Total	46,988		19,817		49,980		1,106		39,050		112,131	

Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

Prepared by the EpiData Center, September 2015



Figure 1. Rate of admissions with an adverse event per 1,000 admissions, 2007 - 2014, by adverse event type



Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

Prepared by the EpiData Center, September 2015



Table 2. Major Diagnostic Categories (MDCs) of index admissions, 2007 – 2014, by adverse event type

MDC Title	Drugs		Devices		Procedures		Radiation		Other		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Alcohol/drug use or induced mental disorders	129	0.3	10	0.0	11	0.0	1	0.1	8	0.0	148	0.1
Blood and blood forming organs and immunological disorders	1,485	3.2	162	0.7	161	0.3	52	3.7	304	0.7	1,917	1.5
Burns	33	0.1	30	0.1	59	0.1	22	1.6	53	0.1	152	0.1
Circulatory system	5,788	12.6	5,470	23.7	4,725	8.5	148	10.6	4,238	10.1	15,458	11.9
Digestive system	4,067	8.8	1,921	8.3	10,127	18.1	286	20.5	5,783	13.7	17,321	13.4
Ear, nose, mouth and throat	809	1.8	242	1.0	1,036	1.9	40	2.9	892	2.1	2,393	1.8
Endocrine, nutritional and metabolic system	2,070	4.5	404	1.8	1,089	2.0	46	3.3	931	2.2	3,761	2.9
Eye	208	0.5	160	0.7	172	0.3	3	0.2	131	0.3	553	0.4
Factors influencing health status	1,299	2.8	193	0.8	512	0.9	32	2.3	433	1.0	2,121	1.6
Female reproductive system	400	0.9	180	0.8	1,389	2.5	8	0.6	1,758	4.2	2,848	2.2
Hepatobiliary system and pancreas	1,288	2.8	671	2.9	3,076	5.5	18	1.3	2,366	5.6	5,309	4.1
Infectious and parasitic diseases and disorders	967	2.1	919	4.0	6,573	11.8	35	2.5	4,122	9.8	7,797	6.0
Injuries, poison and toxic effects of drugs	9,223	20.1	2,088	9.1	5,702	10.2	34	2.4	5,834	13.8	17,636	13.6
Kidney and urinary tract	1,890	4.1	1,734	7.5	1,613	2.9	194	13.9	1,385	3.3	5,248	4.1
Male reproductive system	85	0.2	62	0.3	250	0.4	6	0.4	215	0.5	460	0.4
Mental diseases and disorders	2,437	5.3	25	0.1	48	0.1	1	0.1	38	0.1	2,520	1.9
Multiple significant trauma	82	0.2	175	0.8	453	0.8	2	0.1	314	0.7	716	0.6
Musculoskeletal system and connective tissue	2,820	6.1	5,622	24.4	5,548	9.9	49	3.5	5,741	13.6	14,953	11.5
Myeloproliferative diseases and disorders (poorly differentiated neoplasms)	790	1.7	127	0.6	224	0.4	15	1.1	228	0.5	1,156	0.9
Nervous system	2,800	6.1	832	3.6	2,283	4.1	104	7.4	1,486	3.5	5,952	4.6
Newborn and other neonates (perinatal period)	186	0.4	19	0.1	224	0.4	0	0.0	357	0.8	596	0.5
Pre-MDC	318	0.7	335	1.5	671	1.2	21	1.5	485	1.2	1,306	1.0
Pregnancy, childbirth and puerperium	1,071	2.3	107	0.5	4,172	7.5	5	0.4	816	1.9	5,525	4.3
Respiratory system	3,609	7.8	638	2.8	3,110	5.6	200	14.3	2,104	5.0	7,926	6.1
Skin, subcutaneous tissue and breast	1,930	4.2	621	2.7	1,998	3.6	63	4.5	1,496	3.5	4,575	3.5
Ungroupable	196	0.4	318	1.4	596	1.1	13	0.9	625	1.5	1,230	0.9

Index admissions were defined as those with an adverse event.

There were 13,002 admissions with DRG codes that did not align to an MDC. Percentages are calculated based on admissions with a known MDC.

Darker shaded cells represent higher values within each column.

Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

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Table 3. Incidence of readmission, 2007 – 2014, by adverse event type

Adverse event type	Total index admissions	Readmitted		Readmitted with the same MDC	
		n	%	n	%
Drugs	53,950	7,994	14.8	3,251	6.0
Devices	24,685	4,593	18.6	1,802	7.3
Procedures	58,934	8,553	14.5	3,028	5.1
Radiation	1,463	403	27.5	178	12.2
Other	44,613	6,392	14.3	2,253	5.1
Total	142,579	21,226	14.9	8,142	5.7

Index admissions were defined as those with an adverse event. Readmissions were those that occurred within 30 days of an index admission. An incident readmission was counted if there was at least one readmission.

Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

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Table 4. Burden of readmissions, 2007 – 2014, by adverse event type

Adverse event type	Total index admissions	Total readmissions	Total readmissions with the same MDC
Drugs	53,950	10,166	3,722
Devices	24,685	5,526	1,997
Procedures	58,934	10,016	3,292
Radiation	1,463	532	211
Other	44,613	7,619	2,474
Total	142,579	25,846	9,085

Index admissions were defined as those with an adverse event. Readmissions were those that occurred within 30 days of an index admission. Burden of readmissions was calculated by summing all readmissions.

Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

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Appendix

Frequency and rate of hospital admissions with at least one adverse event, 2007 – 2014, by adverse event type

Year	All admissions	Drug		Device		Procedure		Radiation		Other		Any adverse event	
		n	Rate per 1,000*	n	Rate per 1,000	n	Rate per 1,000	n	Rate per 1,000	n	Rate per 1,000	n	Rate per 1,000
2007	263,350	6,417	24.4	3,081	11.7	8,048	30.6	186	0.7	5,249	19.9	17,803	67.6
2008	257,418	6,716	26.1	2,949	11.5	8,027	31.2	159	0.6	5,502	21.4	18,047	70.1
2009	263,597	6,635	25.2	3,080	11.7	7,651	29.0	153	0.6	5,381	20.4	17,672	67.0
2010	267,714	6,998	26.1	3,027	11.3	7,985	29.8	193	0.7	5,702	21.3	18,255	68.2
2011	265,799	7,089	26.7	3,168	11.9	7,526	28.3	191	0.7	5,588	21.0	18,267	68.7
2012	268,336	7,038	26.2	3,104	11.6	6,793	25.3	166	0.6	5,971	22.3	18,071	67.3
2013	260,652	6,717	25.8	3,123	12.0	6,421	24.6	218	0.8	5,455	20.9	17,392	66.7
2014	256,439	6,340	24.7	3,153	12.3	6,483	25.3	197	0.8	5,765	22.5	17,072	66.6
Total	2,103,305	53,950	25.7	24,685	11.7	58,934	28.0	1,463	0.7	44,613	21.2	142,579	67.8

*Per 1000 admissions

Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

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Total number of adverse events by type, 2007 – 2014	
Adverse event type	Frequency
Drugs	85,433
Devices	31,130
Procedures	71,717
Radiation	2,176
Other	47,938
Total	238,394

Data source: Composite Health Care System (CHCS) Standard Inpatient Data Records (SIDR)

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